RTCA Special Committee 186, Working Group 3

ADS-B 1090 MOPS

Meeting # 12, 9 July 2002

Proposed Changes for DO-260A In Respect To NIC/NAC/SIL and CC and OM Codes

(Presented by James Maynard)

SUMMARY

This paper is presented in support of action items 10-14, 10-15, and 10-16.

AI 10-14: Make updates to WP-10-15 (CC and OM Fields) as discussed during Meeting 10 and present at the next meeting.

AI 10-15: Align the proposed text changes in WP-10-09 and WP-11-01R1 (revised DO-260 for Intent) and WP-11-15 (CC & OM Fields).

AI-10-16: Reference WP-5-10A and make updates necessary to reflect final DO-242A requirements for NIC/NAC/SIL.

Red Text.

In the draft text itself, red text indicates changes from the initial version (DO-260) of the MOPS.

Section	Changes
Throughout	Underlined Figure and Table references. Displayed the requirement marker word "**shall**" in boldface font.
§2.2.3.2.3.1	Listed the various messages types that the TYPE subfield identifies, in a bulleted list with section references. Altered text to specify that the TYPE subfield does not encode NUC_P, but NIC (for airborne position and airborne velocity messages) and altitude type (for airborne position messages only). Revised Table 2-11, which defines the meaning of the different Type Codes in the TYPE subfield. Deleted the column of HFOM values, since the type code no longer encodes NAC. Retitled the "HPL" column to list Horizontal Containment Limit (R_C), Vertical Protection Limit (VPL), and Navigation Integrity Category (NIC) values in that column. Added a Notes column at the right edge of the table. Added *Note 4* after the table to suggest that HPL (or HIL) from an ARINC 743A GNSS receiver is expected to be an appropriate source for R_C, the horizontal containment limit. Added *Note 5* after the table to explain that some of the TYPE code selections imply limits on both R_C and VPL, and that both limits must be satisfied in order for that TYPE code value to be chosen. Added *Notes 6 and 7* after the table to explain that, for certain type codes, the type code alone is not sufficient to determine the NIC code: one must also consult the NIC Supplement field in the Aircraft Operational Status message.
§2.2.3.2.3.1.1	[This section specifies the rules for determining the Type Code in airborne position messages if R_C information IS available.] Deleted references to HPL, replacing with references to R_C. Listed four cases, in subparagraphs a, b, c, d to specify just how the Type Code is determined, depending on whether or not horizontal position information, pressure altitude, and geometric altitude are available.
§2.2.3.2.3.1.2	[This section specifies the rules for determining the Type Code in airborne position messages if R_C information is NOT available.] Replaced references to HPL with references to R_C. Listed three cases, in subparagraphs a, b, and c, to specify which Type Code to use according to whether or not horizontal position, pressure altitude, and geometric altitude are available.
§2.2.3.2.3.1.3.1	[This section explains the "Significance of Type Code Equal to ZERO" in airborne position messages.] The existing wording seemed to apply to more than just ADS-B position messages, which I believe was an error. So I tightened the wording to make it clear that this describes only Type Code = 0 in Airborne Position messages. (There's a similar section for Surface Position Messages.) Demoted an explanatory comment from body text to a *Note*.
§2.2.3.2.3.1.3.2	[This section describes conditions for broadcasting a type code of ZERO in airborne position messages.] Adding qualifying words "airborne position or surface position" before "ADS-B message register" to clarify that type code ZERO is not used for messages that are not position messages.
§2.2.3.2.3.1.4	[This section describes the rules for determining the type code in airborne position messages, based on horizontal position and altitude data.] Added a subparagraph "c" to specify how to select the type code when neither pressure altitude nor geometric altitude is available, but horizontal position is available. (The DO-260 text did not consider this case.)
§2.2.3.2.4	[This section introduces the Surface Position Message.] In Figure 2-5 that shows the overall format of the message, renamed the "Ground Track Status" and "Ground Track" subfields to "Heading Status" and "Heading," respectively, in accordance with changes in DO-242A.

Section	Changes
§2.2.3.2.4.1.1	[This section specifies how the Type Code in Surface Position messages is determined when the containment radius, R_C, ***is*** available.] Replaced references to HPL with references to R_C. Added a *Note* that HPL (or HIL) from a GNSS receiver is a suitable source of R_C.
§2.2.3.2.4.1.2	[This section specifies how the Type Code in Surface Position messages is determined if R_C ***is not*** available.] Replaced references to HPL with references to R_C. Added subparagraphs "a" and "b" to explicitly state when Type Code values of "0" and "8" are to be selected, according the absence or presence of horizontal position information.
§2.2.3.2.4.1.4	[This section explicitly specifies how the Type Code is selected in Surface Position messages when horizontal position information ***is*** available, according to whether or not R_C information is available.] Deleted references to HFOM, since the Type Code now encodes NIC, but not NAC.
§2.2.3.2.4.3	[This section describes the STATUS BIT FOR HEADING subfield in ADS-B Surface Position messages.] Replaced "track angle" with "heading" throughout this section in accordance with changes in DO-242A. Added a *Note* that track angle may only be used as an estimate of heading if the "STATUS BIT FOR HEADING" field is cleared to 0 whenever the track angle is *not* a good estimate of heading (e.g., when the ground speed is zero, or nearly zero.)
§2.2.3.2.4.4	[This section describes the HEADING subfield in Surface Position messages.] The section was reworded to replace "track angle" with "heading" in accordance with changes in DO-242A. Added a *Note* that the reference direction for heading (True North or Magnetic North) is specified in a subfield of the Aircraft Operational Status message.

Section	Changes
§2.2.3.2.7.3	[This section introduces the Aircraft Operational Status message.] Modified Figure 2-10, which shows the overall message format, to include the new subfields, and *not* to show the CC and OM subfields each divided into 4 four-bit sub-subfields.
§2.2.3.2.7.3.2	[This section describes the SUBTYPE subfield of Aircraft Operational Status messages.] Added subtype 1 to the list of permissible subtypes in the Aircraft Operational Status message. The subtype 1 variant contains data (Length and Width Codes, and Heading Reference Direction) that is expected to be needed more frequently from surface participants, while the subtype 1 variant contains data (Barometric Altitude Quality) that is needed only from airborne participants.
§2.2.3.2.7.3.3	[This section describes the CC subfield in the Aircraft Operational Status message.] Extensively changes in accordance with my proposal in WP-10-15: 1. Table 2.2.3.2.7.3.3-A summarizes CC code field for Version 0 (DO-260) transmitting subsystems. 2. Table 2.2.3.2.7.3.3-B does the same for Version 1 (DO-260A) transmitting subsystems. In that table, the Service Level subfield occupies Message bits 9, 10, 13, and 14 and will be used to determine which CC codes occupy the other bits of the CC codes subfield. For this edition of the MOPS, only Service Level 0 is defined.
§2.2.3.2.7.3.3.1	[This section describes the Service Level CC code.] The Service Level is defined to be ZERO.
§2.2.3.2.7.3.3.2	[This section describes the "~TCAS" CC code. For compatibility with DO-260 "Version 0" (DO-260 compliant) equipment, this message field has an opposite sense from the corresponding field in the MS report.
§2.2.3.2.7.3.3.3	[This section describes the "CDTI Display Capability" CC code.]
§2.2.3.2.7.3.3.4	[This section describes the "ARV Report Capability" CC code.]
§2.2.3.2.7.3.3.5	[This section describes the "TS Report Capability" CC code.]
§2.2.3.2.7.3.3.6	[This section describes the "TC Report Capability Level" CC code.]
§2.2.3.2.7.3.3.7	[This section describes the "Position Offset Applied" CC code.]
§2.2.3.2.7.3.4	[This section describes the OM subfield in the Aircraft Operational Status message.] Extensive changes in accordance with my proposal in WP-10-15 and for compliance with DO-242A. Table 2.2.3.2.7.3.4 lays out the overall format of the OM subfield.
§2.2.3.2.7.3.4.1	[This section describes the first two bits of the OM subfield, which are reserved for selecting one of four possible OM subfield formats.] For this version of the MOPS, these bits shall be ZERO.
§2.2.3.2.7.3.4.2	[This section describes the "TCAS/ACAS Resolution Advisory Active" OM code.]
§2.2.3.2.7.3.4.3	[This section describes the "IDENT Switch Active" OM Code.]
§2.2.3.2.7.3.4.4	[This section describes the "Receiving ATC Services" OM Code.]
§2.2.3.2.7.3.5.	[This section describes the Version Number subfield in the Aircraft Operational Status message.] Table 2.2.3.2.7.3.5 gives the coding of the Version Number subfield, showing not only the MOPS version, but also the ADS-B MASPS version, for each coding of the Version Number subfield.

Section	Changes
§2.2.3.2.7.3.6	[This section describes the "NIC supplement" subfield in the Aircraft Operational Status message.] It includes a table of possible NIC values, showing how each NIC value is encoded, partly in the Type Code in airborne position and surface position messages, and partly in the NIC supplement subfield of Aircraft Operational Status messages.
§2.2.3.2.7.3.7	[This section describes NAC_P, the Navigation Accuracy Category for Position.]
§2.2.3.2.7.3.8	[This section describes SIL, the Surveillance Integrity Level.]
§2.2.3.2.7.3.9	[This section describes the "Reserved for Barometric Altitude Quality (BAQ)" subfield of the Aircraft Operational Status message.]
§2.2.3.2.7.3.10	{This section describes NIC_{baro}, the Barometric Altitude Integrity Code.]
§2.2.3.2.7.3.11	[This section describes HRD, the Horizontal Reference Direction.]
§2.2.3.2.7.3.12	[This section described the "not assigned" remaining bits of the Aircraft Operational Status message.]

2.2 Minimum Performance Standards - Standard Conditions and Signals

2.2.1 Definition of Standard Conditions

2.2.2 ADS-B Transmitter Characteristics

2.2.3 Broadcast Message Characteristics

2.2.3.1 ADS-B Message Characteristics

2.2.3.2 ADS-B Message Format Structure

2.2.3.2.1 ADS-B Message Baseline Format Structure

2.2.3.2.2 DF=17 and 18 Format Structures

2.2.3.2.3 ADS-B Airborne Position Messages

Format for the Airborne Position Message "ME" field contents is defined in Figure 2-3. Each of the subfields is defined in the following subparagraphs.

AIRBORNE POSITION MESSAGE "ME" FIELD								
MSG BIT #	33--37	38 ---------- 39	40	41 ------ 52	53	54	55 --------- 71	72 --------- 88
"ME" BIT #	1 --- 5	6 ---------- 7	8	9 ------- 20	21	22	23 --------- 39	40 --------- 56
FIELD NAME	TYPE [5]	SURVEILLANCE STATUS [2]	SINGLE ANTENNA [1]	ALTITUDE [12]	TIME (T) [1]	CPR FORMAT (F) [1]	ENCODED LATITUDE [17]	ENCODED LONGITUDE [17]
	MSB LSB	MSB LSB	MSB LSB	MSB LSB			MSB LSB	MSB LSB

Note: *"[#]" provided in the Field indicates the number of bits in the field.*

Figure 2-3: ADS-B Airborne Position Message Format

2.2.3.2.3.1 "TYPE" Subfield in ADS-B Airborne Position Messages

The "TYPE" subfield is a 5-bit ("ME" bits 1 through 5, Message bits 33 through 37) field that is used to identify the ADS-B Message and to differentiate the messages into several message types:

- Airborne position message (§2.2.3.2.3),
- Surface position message (§2.2.3.2.4),
- Aircraft ID and type message (§2.2.3.2.5),
- Airborne velocity message (§2.2.3.2.6),
- Aircraft trajectory intent message (§2.2.3.2.7.1)
- Aircraft operational coordination message (§2.2.3.2.7.2)
- Aircraft operational status message (§2.2.3.2.7.3)
- Aircraft status message (§2.2.3.2.7.9)

In the case of airborne position messages, the message TYPE subfield also encodes the Navigation Integrity Category (NIC, §TBD) and the altitude type (barometric pressure altitude, §TBD, or geometric altitude, §TBD). For surface position messages, the TYPE subfield encodes NIC – but not altitude type, since altitude is not reported in surface position messages.

Detailed definition of the "TYPE" subfield encodings that **shall** be used for all ADS-B messages are provided in Table 2-11.

The ADS-B Airborne Position Messages **shall** use only "TYPE" codes 0, 9 through 18, and 20 through 22 as indicated in Table 2-11.

Table 2-11: "TYPE" Subfield Code Definitions (DF = 17 or 18)

Type Code	Format (Message Type)	Horizontal Containment Limit (R_C) and Navigation Integrity Category (NIC)	Altitude Type	Notes
0	No Position Information (**Airborne Position Message** or **Surface Position Message**)	R_C unknown NIC = 0	Baro Altitude *or* No Altitude Information	1, 2, 3
1	**Aircraft Identification and Type Message** (§2.2.3.2.5)	*Not Applicable*	*Not Applicable*	Category Set D
2		*Not Applicable*	*Not Applicable*	Category Set C
3		*Not Applicable*	*Not Applicable*	Category Set B
4		*Not Applicable*	*Not Applicable*	Category Set A
5	**Surface Position Message** (§2.2.3.2.4)	R_C < 7.5 m NIC = 11	No Altitude Information	
6		R_C < 75 m NIC = 9 or 10		6
7		R_C < 0.1 NM (185.2 m) NIC = 8		
8		R_C = 0.1 NM (185.2 m) or unknown NIC = 0		
9	**Airborne Position Message** (§2.2.3.2.3)	R_C < 7.5 m *and* VPL < 11 m NIC = 11	Baro Altitude	5
10		R_C < 75 m *and* VPL < 112 m NIC = 9 or 10		5, 6
11		R_C < 0.1 NM (185.2 m) NIC = 8		
12		R_C < 0.2 NM (370.4 m) NIC = 7		
13		R_C < 0.6 NM (1111.2 m) NIC = 6		
14		R_C < 1.0 NM (1852 m) NIC = 5		
15		R_C < 2 NM (3.704 km) NIC = 4		
16		R_C < 8 NM (14.816 km) NIC = 2 or 3		7
17		R_C < 20 NM (37.04 km) NIC = 1		
18		R_C = 20 NM (37.04 km) or unknown NIC = 0		
19	**Airborne Velocity Message (§2.2.3.2.6)**	*Not Applicable*	*Difference between "Baro Altitude" and "GNSS Height (HAE)"*	
20	**Airborne Position Message (§2.2.3.2.3)**	R_C < 7.5 m *and* VPL < 11 m NIC = 11	GNSS Height (HAE)	2, 5
21		R_C < 25 m *and* VPL < 37.5 m NIC = 10		2, 5
22		R_C = 25 m *or* VPL = 37.5 m *or* R_C or VPL unknown NIC = 0		2
23	**Reserved for Test Purposes (§2.2.3.2.7.4)**			
24	**Reserved for Surface System Status (§2.2.3.2.7.5)**			
25 - 27	**Reserved (§2.2.3.2.7.6 to §2.2.3.2.7.8)**			
28	**Aircraft Status Message (§2.2.3.2.7.9)**			
29	**Aircraft Trajectory Intent Message (§2.2.3.2.7.1)**			
30	**Aircraft Operational Coordination Message** (§2.2.3.2.7.2)			
31	**Aircraft Operational Status Message** (§2.2.3.2.7.4)			

Notes for Table 2-11:

1. *"Baro Altitude" means barometric pressure altitude, relative to a standard pressure of 1013.25 millibars (29.92 in.Hg.). It does **not** mean baro corrected altitude.*

2. *Type codes 20 to 22 or Type Code 0 are to be used when valid "Baro Altitude" is not available.*

3. *After initialization, when horizontal position information is not available but altitude information is available, the airborne position message is transmitted with a type code of zero in bits 1-5, the barometric pressure altitude in bits 9 to 20, and bits 22 to 56 set to zero. If neither horizontal position nor barometric altitude information is available, then all 56 bits of register 0,5 are set to zero. The zero type code field indicates that latitude and longitude information is not available, while the zero altitude field indicates that altitude information is not available. (See Appendix A).*

4. *If the position source is an ARINC 743A GNSS receiver, then the ARINC 429 data "label 130" data word from that receiver is a suitable source of information for R_C, the horizontal integrity containment radius. (The label 130 data word is variously called HPL (Horizontal Protection Limit) or HIL (Autonomous Horizontal Integrity Limit) in different documents.*

5. *This TYPE code value implies limits for both R_C (horizontal containment limit) and VPL (Vertical Protection Limit). If either of these limits is not satisfied, then a different value for the TYPE code should be selected.*

6 *The "NIC supplement" field in the Aircraft Operational Status message (§2.2.3.2.7.3.6) enables the report assembly function in ADS-B receiving equipment to determine whether the transmitting ADS-B subsystem is announcing NIC = 9 (R_C < 75 m and VPL < 112 m) or NIC = 10 (R_C < 25 m and VPL < 37.5 m).*

7 *The "NIC supplement" field in the Aircraft Operational Status message (§2.2.3.2.7.3.6) enables the report assembly function in ADS-B receiving equipment to determine whether the transmitting ADS-B subsystem is announcing NIC = 2 (R_C < 8 NM) or NIC = 3 (R_C < 4 NM).*

2.2.3.2.3.1.1 Airborne Position Message Type Code if Containment Radius is Available

Note: If the position information comes from a GNSS receiver that conforms to the ARINC 743A characteristic, a suitable source of information for the containment radius (R_C), is ARINC 429 label 130 from that GNSS receiver.

If R_C (containment radius) information is available from the navigation data source, then the transmitting ADS-B subsystem **shall** determine the type code (the value of the TYPE subfield) of airborne position messages as follows.

a. If current valid horizontal position information is not available to the ADS-B transmitting subsystem, it **shall** set the TYPE subfield of airborne position messages to ZERO as described in §2.2.3.2.3.1.3.2 below.

b. If valid horizontal position and barometric pressure altitude information are both available to the ADS-B transmitting subsystem, the ADS-B transmitting subsystem **shall** set the TYPE subfield of airborne position messages to a value in the range from 9 to 18 in accordance with Table 2-11.

c. If valid horizontal position information is available to the ADS-B transmitting subsystem, but valid barometric pressure altitude information is *not* available, and valid geometric altitude information *is* available, the ADS-B transmitting subsystem **shall** set the TYPE subfield of airborne position messages to a value in the range from 20 to 22 depending on the containment radius R_C and vertical protection limit VPL in accordance with Table 2-11.

d. If valid horizontal position information is available to the ADS-B transmitting subsystem, but neither valid barometric altitude information nor valid geometric altitude information is available, the ADS-B transmitting subsystem **shall** set the TYPE subfield in airborne position messages to a value in the range from 9 to 18 depending on the containment radius R_C in accordance with Table 2-11. (In that case, the ALTITUDE subfield of the airborne position messages would be set to all zeroes in accordance with §2.2.3.2.3.4.3 below, in order to indicate that valid altitude information is not available.)

2.2.3.2.3.1.2 Airborne Position Message Type Code if Containment Radius is Not Available

If R_C (containment radius) information is NOT available from the navigation data source, then the transmitting ADS-B subsystem **shall** indicate NIC = 0 by selecting a Type Code of 0, 18, or 22 in the Airborne Position Messages, as follows:

a. It **shall** set the TYPE subfield to ZERO if valid horizontal position information is not available, as described in §2.2.3.2.3.1.3.2 below.

b. It **shall** set the TYPE subfield to 18 if valid pressure altitude information is available, or if neither valid pressure altitude nor valid geometric altitude information is available.

c. If valid pressure altitude is not available, but valid geometric altitude information is available, it **shall** set the TYPE subfield to 22.

2.2.3.2.3.1.3 Special Processing for Type Code ZERO

2.2.3.2.3.1.3.1 Significance of Type Code Equal to ZERO

As shown in Table 2-11, Type Code equal to ZERO (0) is labeled "No Position Information." This type of message is intended to be used when horizontal position information is not available or is invalid, and still permit the reporting of barometric altitude, when it is available and valid. As such, the principal use of this message case is to provide TCAS the ability to passively receive altitude information.

Airborne position messages may be transmitted with a Type Code of "0" under the following condition:

An airborne position message with a Type Code of "0" **shall** set all 56 bits of the "ME" field bits to ZERO (0) if NO barometric pressure altitude data is available. If valid pressure altitude data is available, then the "Altitude" subfield, "ME" bits 9 - 20, Message bits 41 - 52, **shall** report the altitude in accordance with paragraph 2.2.3.2.3.4.3.

Note: Special processing is required for airborne position messages because a CPR encoded value of all ZEROs in the latitude and longitude field is considered to be a valid encoding.

2.2.3.2.3.1.3.2 Broadcast of Type Code Equal to ZERO

The Type Code Equal to ZERO message may be required as a consequence of the following events:

a. An airborne position or surface position ADS-B message register has not been loaded with data in the last 2 seconds. In this case, the ADS-B message register **shall** be cleared (i.e., all 56 bits set to ZERO) once it has timed out. Transmission of the ADS-B message that broadcasts the contents of the register **shall** be terminated if the ADS-B message register has not been loaded in 60 seconds. Broadcast of the airborne position or surface position ADS-B message **shall** resume once data has been loaded into the ADS-B message register.

b. The data management function responsible for loading the ADS-B message registers determines that all navigation sources that can be used for the airborne or surface position message are either missing or invalid. In this case the data management function **shall** clear (set all data fields to all ZEROs) the Type Code and all other fields of the airborne or surface position message and insert the ZEROed message into the appropriate ADS-B message register. This should only be done once in support of the detection of the loss of data insertion and shall result in the suppression of the broadcast of the related ADS-B message.

c. Note that in all of the cases discussed above, a Type Code of ZERO infers a message of all ZEROs. The only exception is that the airborne position format **shall** contain barometric altitude code as set by the transponder when so implemented. There is no analogous case for the other extended squitter message types, since a ZERO value in any of the fields indicates that no valid information is available.

2.2.3.2.3.1.4 Type Code based on Horizontal Position and Altitude Data

a. If valid horizontal position information is available, and valid pressure altitude information is available, then the "TYPE" code in the airborne position message **shall** be set in the range from "9" to "18."

b. If valid horizontal position information is available, valid pressure altitude is NOT available, and GNSS Height Above Ellipsoid (HAE) data is available, then the "TYPE" code in the airborne position message **shall** be set in the range from "20" to "22."

c. If valid horizontal position information is available, but neither valid pressure altitude information nor valid GNSS Height Above Ellipsoid (HAE) information is available, then the "TYPE code in the airborne position message **shall** be set in the range from "9" to "18."

In all three cases, "a," "b," and "c" above, the "TYPE" coding shall be selected in accordance with the containment radius, R_C, given in Table 2-11.

2.2.3.2.4 ADS-B Surface Position Messages

The format for the Surface Position Message "ME" field contents is defined in Figure 2-5. Each of the subfields is defined in the following subparagraphs.

SURFACE POSITION MESSAGE "ME" FIELD								
MSG BIT #	33--37	38 --------- 44	45	46 --------- 52	53	54	55 --------- 71	72 --------- 88
"ME" BIT #	1 --- 5	6 ---------- 12	13	14 --------- 20	21	22	23 --------- 39	40 --------- 56
FIELD NAME	TYPE [5]	MOVEMENT [7]	HEADING STATUS [1]	HEADING [7]	TIME (T) [1]	CPR FORMAT (F) [1]	ENCODED LATITUDE [17]	ENCODED LONGITUDE [17]
	MSB LSB	MSB LSB		MSB LSB			MSB LSB	MSB LSB

Note: *"[#]" provided in the Field indicates the number of bits in the field.*

Figure 2-5: ADS-B Surface Position Message Format

2.2.3.2.4.1 "TYPE" Subfield in ADS-B Surface Position Messages

The "TYPE" subfield was previously defined for the Airborne Position Message in subparagraph 2.2.3.2.3.1 and remains the same for the ADS-B Surface Position Message, which **shall** use Type Codes 5, 6, 7 and 8 only.

Detailed definition of the "TYPE" subfield encodings that **shall** be used for all ADS-B messages are provided in Table 2-11.

2.2.3.2.4.1.1 Surface Position Message Type Code if Containment Radius is Available

If R_C (horizontal containment radius) information is available from the navigation data source, then the transmitting ADS-B subsystem **shall** use R_C to determine the Type Code used in the Surface Position Message in accordance with Table 2-11.

Note: If the position information comes from a GNSS receiver that conforms to the ARINC 743A characteristic, a suitable source of information for the containment radius (R_C), is ARINC 429 label 130 from that GNSS receiver.

2.2.3.2.4.1.2 Surface Position Message Type Code if Containment Radius is Not Available

If R_C (horizontal containment radius) information is NOT available from the navigation data source, then the transmitting ADS-B subsystem **shall** indicate NIC = 0 by selecting a Type Code of 0 or 8 in the Surface Position Messages, as follows:

a. The transmitting ADS-B subsystem **shall** set the TYPE subfield to ZERO if valid horizontal position information is not available, as described in §2.2.3.2.3.1.3.2 above.

b. The transmitting ADS-B subsystem **shall** set the TYPE subfield to 8 if valid horizontal position information is available. (This Type Code indicates that containment radius, R_C, is either unknown or greater than or equal to 0.1 NM.)

2.2.3.2.4.1.3 Special Processing for Type Code ZERO

2.2.3.2.4.1.3.1 Significance of Type Code Equal to ZERO

As shown in Table 2-11, Type Code equal to ZERO (0) is labeled "No Position Information." This type of message is intended to be used when the latitude and/or longitude information is not available or is invalid.

A surface position message with a Type Code of "0" shall have all 56 bits of the "ME" field set to ZERO.

Special processing is required for surface position messages because a CPR encoded value of all ZEROs in the latitude and longitude field is considered to be a valid encoding.

2.2.3.2.4.1.3.2 Broadcast of Type Code Equal to ZERO

The requirements provided in section 2.2.3.2.3.1.3.2 apply equally to the surface position message except that subparagraph "c" is modified to read as follows:

Note that in all of the cases, a Type Code of ZERO infers a message of all ZEROs.

2.2.3.2.4.1.4 Type Code based on Containment Radius

If valid horizontal position information is available, then the "TYPE" code in the surface position message **shall** be set in the range from "5" to "8," According to the availability and value of R_C (horizontal containment radius) information from the navigation data source.

a. If R_C (horizontal containment radius) information is available from the navigation data source, the "TYPE" coding **shall** be selected according to the R_C value, in accordance with Table 2-11.

b. If R_C is not available from the navigation data source, then the "TYPE" coding **shall** be set to 8.

2.2.3.2.4.2 "MOVEMENT" Subfield in ADS-B Surface Position Messages

The "MOVEMENT " subfield is a 7-bit ("ME" bits 6 through 12, Message bits 38 through 44) field that is used to encode information regarding the status of "Movement" of the ADS-B transmitting device in accordance with the coding provided in Table 2-13.

Table 2-13: "MOVEMENT" Subfield Code Definitions

Encoding	Meaning	Quantization
0	No Movement Information Available	
1	Aircraft Stopped (Ground Speed < 0.2315 km/h (0.125 knots)	
2 - 8	0.2315 km/h (0.125 kt) = Ground Speed < 1.852 km/h (1 kt)	0.2315 km/h (0.125 kt) steps
9 - 12	1.852 km/h (1 kt) = Ground Speed < 3.704 km/h (2 kt)	0.463 km /h (0.25 kt) steps
13 - 38	3.704 km/h (2 kt) = Ground speed < 27.78 km/h (15 kt)	0.926 km/h (0.50 kt) steps
39 - 93	27.78 km/h (15 kt) = Ground Speed < 129.64 km/h (70 kt)	1.852 km/h (1.00 kt) steps
94 - 108	129.64 km/h (70 kt) = Ground Speed < 185.2 km/h (100 kt)	3.704 km/h (2.00 kt) steps
109 - 123	185.2 km/h (100 kt) = Ground Speed < 324.1 km/h (175 kt)	9.26 km/h (5.00 kt) steps
124	324.1 km/h (175 kt) = Ground Speed	
125	Reserved for Aircraft Decelerating	
126	Reserved for Aircraft Accelerating	
127	Reserved for Aircraft Backing-Up	

Notes:

1. *The data encoding represented in Table 2-13 represents a non-linear encoding: therefore, encoding shall be performed exactly as defined in the table.*

2. *The last three movement encodings (125, 126, 127) are reserved to indicate high levels of ground speed change, etc. The precedence of the codes is not defined yet as inputs that would be required are not currently available.*

2.2.3.2.4.3 "STATUS BIT FOR HEADING" Subfield in ADS-B Surface Position Messages

The "Status Bit for Heading " subfield is a 1-bit ("ME" bit 13, Message bit 45) field that **shall** be used to indicate the validity of the Heading as defined in Table 2-14.

Table 2-14: "STATUS BIT FOR HEADING" Encoding

Coding	Meaning
0	Heading data is NOT VALID
1	Heading data is VALID

*Note: If a source of A/V heading **is not** available to the ADS-B transmitting subsystem, but a source of ground track angle **is** available, ground track angle may be used instead of heading, provided that the STATUS BIT FOR HEADING subfield is set to zero whenever the ground track angle is not a reliable indication of the A/V's heading. (The ground track angle is not a reliable indication of the A/V's heading when the A/V's ground speed is close to zero.)*

2.2.3.2.4.4 "HEADING" Subfield in ADS-B Surface Position Messages

Table 2-15: "HEADING" Encoding

Coding (binary)	Coding (decimal)	Meaning (Heading in degrees)
000 0000	0	Heading is ZERO
000 0001	1	Heading = 2.8125 degrees
000 0010	2	Heading = 5.6250 degrees
000 0011	3	Heading = 8.4375 degrees
***	***	***
011 1111	63	Heading = 177.1875 degrees
100 0000	64	Heading = 180.0000 degrees
100 0001	65	Heading = 182.8125 degrees
***	***	***
111 1111	127	Heading = 357.1875 degrees

Notes:

1. *The encoding shown in the table represents an angular weighted binary encoding in degrees clockwise from north. The MSB represents a bit weighting of 180 degrees, while the LSB represents a bit weighting of 360/128 degrees.*
2. *Raw data used to establish the Heading subfield will normally have more resolution (i.e., more bits) than that required by the Heading Subfield. When converting such data to the Heading Subfield, the accuracy of the data must be maintained such that it is not worse than +/- ½ LSB where "LSB" is the weight of the least significant bit of the Heading subfield.*
3. *The reference direction for Heading (whether True North or Magnetic North) is indicated in the Horizontal Reference Direction (HRD) field of the Aircraft Operational Status message (§2.2.3.2.7.3.13).*
4. *When both Magnetic Heading and True Heading are available, it is preferred to transmit True Heading.*

2.2.3.2.4.5 "TIME" (T) Subfield in ADS-B Surface Position Messages

2.2.3.2.4.6 "CPR FORMAT" (F) Subfield in ADS-B Surface Position Messages

2.2.3.2.4.7 "ENCODED LATITUDE" Subfield in ADS-B Surface Position Messages

2.2.3.2.4.8 "ENCODED LONGITUDE" Subfield in ADS-B Surface Position Messages

2.2.3.2.5 ADS-B Aircraft Identification and Type Messages

2.2.3.2.6 ADS-B Airborne Velocity Information Messages

2.2.3.2.7 ADS-B Intent and System Status, Operational Coordination, and Operational Status Messages

Type codes 29, 30 and 31 have been identified for Aircraft Intent and System Status, Aircraft Operational Coordination, and Aircraft Operational Status messages. The structure of these messages is provided in detail in the subsequent paragraphs.

2.2.3.2.7.1 "Aircraft Trajectory Intent and System Status" Messages

2.2.3.2.7.2 "Aircraft Operational Coordination" Messages

2.2.3.2.7.3 "AIRCRAFT OPERATIONAL STATUS" Messages

The "Aircraft Operational Status" message is used to provide the current status of the aircraft. The message format is provided in Figure 2-10, while further definition of each of the subfields is provided in the subsequent paragraphs.

	"AIRCRAFT OPERATIONAL STATUS" MESSAGE "ME" FIELD												
Msg Bit #	33 37	38 40	41 52	53 56	57 72	73 75	76	77 80	81 82	83 84	85	86	87 88
"ME" Bit #	1 5	6 8	9 20	21 24	25 40	41 43	44	45 48	49 50	51 52	53	54	55 56
Field Name	**Type = 31** [5]	**Subtype = 0** [3]	**Capability Class (CC) Codes** [16]		**Operational Mode (OM) Codes** [16]	**Version No.** [3]	**NIC Supp.** [1]	**NAC_P** [4]	**BAQ = 0** [2]	**SIL** [2]	**NIC_{baro}** [1]	**HRD [1]**	**Reserved** [2]
		Subtype = 1 [3]	**CC Codes** [12]	**L/W Codes** [4]					**Reserved** [2]		**TRK/HDG** [1]		
	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB	MSB LSB	MSB LSB	MSB LSB	MSB	MSB LSB	

Figure 2-10: "Aircraft Operational Status" ADS-B Message Formats.

2.2.3.2.7.3.1 "TYPE" Subfield in Aircraft Operational Status Messages

The "TYPE" subfield was previously defined for the Airborne Position Message in §2.2.3.2.3.1 and remains the same for the Aircraft Operational Status ~~ADS-B Event-Driven~~ Message which uses Type Code 31 (and Subtypes 0 and 1).

2.2.3.2.7.3.2 "SUBTYPE" Subfield in Aircraft Operational Status Messages

The "SUBTYPE" subfield is a 3-bit ("ME" bits 6 through 8, Message bits 38 through 40) subfield used to indicate various types of Aircraft Operational Status messages as defined in Table 2-53.

Table 2-53: "SUBTYPE" Subfield in Aircraft Operational Status Messages Encoding

Subtype Coding	Meaning
0	Message contains Aircraft Operational Status Message in the Airborne Format
1	Message contains Aircraft Operational Status Message in the Surface Format
2 - 7	Reserved

2.2.3.2.7.3.3 "CAPABILITY CODES (CC)" Subfield in Aircraft Operational Status Messages

The Capability Codes (CC) subfield of Aircraft Operational Status Message occupies 16 bits in the "airborne" format of that message and 12 bits in the "surface" format of the message. In the airborne format (message with Type = 31, Subtype = 0), the CC codes occupy "ME" bits 9 through 24 (Message bits 41 through 56). In the surface format (Type Code = 31, Subtype = 1), the CC codes occupy "ME" bits 9 through 20 (Message butes 41 thorugh 52). The format of this subfield depends on the Version Number subfield (§2.2.3.2.7.3.5). Moreover, for messages transmitted from "version 1" ADS-B transmitting equipment, the CC format depends on whether the message Subtype field is has a value of 0 or 1.

If the Version Number subfield (§2.2.3.2.7.3.5) is 0, the format of the CC subfield is as defined in the initial (DO-260) version of this MOPS. This is summarized in Table 2.2.3.2.7.3.3-A below.

Table 2.2.3.2.7.3.3-A: Capability Class (CC) Code Format in Version 0 Transmitting Susbystems.

Msg Bit #	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
"ME" Bit #	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Content	0	0	~TCAS	CDTI	Unused											

Notes for Table 2.2.3.2.7.3.3-A:

~TCAS = "TCAS/ACAS Not Installed Or Not Operational"
CDTI = "CDTI Traffic Display Capability"
Reserved = "Reserved for standardization in future versions of this MOPS"

If the Version Number subfield (§2.2.3.2.7.3.4) is 1 and the Subtype subfield is 0, the format of the CC subfield **shall** be as defined in Table 3.3.4.3.7.3.3.-B below.

Table 2.2.3.2.7.3.3-B: Airborne Capability Class (CC) Code Format in Version 1 Transmitting Subsystems.

Msg Bit #	41	42	43	44	45	46	47	48	49	50	51	53 -- 56
"ME" Bit #	9	10	11	12	13	14	15	16	17	18	19	21 -- 24
Content	**Service Level** MSBs = 0 0		**~TCAS**	**CDTI**	**Service Level** LSBs = 0 0		**ARV**	**TS**	**TC**		**POA**	Reserved

Notes for Table 2.2.3.2.7.3.3-B:

~TCAS = "TCAS/ACAS Not Installed Or Not Operational"
CDTI = "CDTI Traffic Display Capability"
ARV = "ARV Report Capability"
TS = "TS Report Capability"
TC = "TC Report Capability Level"
Reserved = "Reserved for standardization in future versions of this MOPS"

If the Version Number subfield (§2.2.3.2.7.3.4) is 1 and the Subtype subfield is 1, the format of the CC subfield shall be as defined in Table 3.3.4.3.7.3.3.-C below.

Table 2.2.3.2.7.3.3-C: Surface Capability Class (CC) Code Format in Version 1 Transmitting Subsystems.

Msg Bit #	41	42	43	44	45	46	47	48	49	50	51	52
"ME" Bit #	9	10	11	12	13	14	15	16	17	18	19	20
Content	**Service Level** MSBs = 0 0		**POA**	**CDTI**	**Service Level** LSBs = 0 0		**Reserved**					

Notes for Table 2.2.3.2.7.3.3-C:

CDTI = "CDTI Traffic Display Capability"
POA = "Position Offset Applied"
Reserved = "Reserved for standardization in future versions of this MOPS"

2.2.3.2.7.3.3.1 "Reserved for Service Level" CC Code Subfield

Within the CC Code subfield, a four-bit subfield ("ME" bits 41-42, 45- 46, Message bits 9-10, 13-14) is reserved for the "service level" of the transmitting ADS-B participant. ADS-B equipment conforming to the current version (DO-260A) of these MOPS **shall** set the Service Level code to ALL ZEROES.

Note: When service levels are defined in the ASA MASPS, future versions of these MOPS will define values other than zero for this CC code subfield.

2.2.3.2.7.3.3.2 "~TCAS" CC Code Subfield

The "~TCAS" (pronounced "not Tee Cass") subfield of the CC codes subfield in Aircraft Operational Status messages is so called because it is encoded with the opposite sense from that of the "TCAS/ACAS Installed and Operational" field in Mode State reports (§TBD). This subfield is available if the Version Number subfield is zero (indicating that the message comes from a DO-260 transmitting subsystem), or if the Version Number subfield is one and the Subtype subfield is 0 (indicating that the message comes from a DO-260A transmitting subsystem that is airborne).

The coding of this subfield, and of the corresponding subfield in Mode Status reports, **shall** be as specified in Table 2.2.3.2.7.3.3.1 below.

Table 2.2.3.2.7.3.3.1: Encoding of "~TCAS" CC Subfield in Aircraft Operational Status Messages.

"~TCAS" CC Code Encoding in Aircraft Operational Status Message	"TCAS/ACAS Installed and Operational" CC Code Encoding in MS Report	Meaning
0	1	TCAS operational or unknown
1	0	TCAS not installed or not operational

The "~TCAS" CC code in Aircraft Operational Status Messages **shall** be set to ZERO in Aircraft Operational Status messages if the transmitting aircraft is fitted with a TCAS II or ACAS computer and that computer is turned on and operating in a mode that can generate Resolution Advisory (RA) alerts. Likewise, this CC code in Aircraft Operational Status messages **shall** be set to ZERO if the transmitting ADS-B equipment cannot ascertain whether or not a TCAS II or ACAS computer is installed, or cannot ascertain whether that computer, if installed, is operating in a mode that can generate RA alerts. Otherwise, this CC code in Aircraft Operational Status messages **shall** be set to ONE.

Notes:

1. *The corresponding "TCAS/ACAS Operational" CC code in MS reports (§TBD) has opposite sense: a ONE in the CC code in the MS report means "TCAS/ACAS operational or unknown," while a ZERO in that part of the MS report means "TCAS/ACAS not installed or not operational."*
2. *The encoding of this CC code subfield in the Aircraft Operational Status message is chosen for compatibility with the initial (DO-260) version of these MOPS. The coding of the corresponding subfield in the MS report (§TBD) is chosen for compliance with the current version (DO-242A) of the ADS-B MASPS.*
3. *It is the responsibility of the Report Assembly Function (§TBD) to invert the "~TCAS" CC code as received in Aircraft Operational Status messages to form the "TCAS/ACAS Installed and Operational" CC code in MS reports.*

2.2.3.2.7.3.3.3 "CDTI Traffic Display Capability" CC Code

The CC code for "CDTI Traffic Display Capability" in Aircraft Operational Status messages (Type = 31, Subtype = 0 or 1) that **shall** be set to ONE if the transmitting aircraft has a Cockpit Display of Traffic Information (CDTI) installed and that display is currently operating in a mode capable of displaying nearby ADS-B traffic. Otherwise, this CC code **shall** be ZERO.

2.2.3.2.7.3.3.4 "ARV Report Capability" CC Code Subfield

The ARV Report Capability subfield of the CC Codes subfield is a one-bit Boolean flag that **shall** be encoded as in Table 2.2.3.2.7.3.3.4:

Table 2.2.3.2.7.3.3.4: ARV Report Capability Encoding.

ARV Report Capability Flag	Meaning
0	No capability for Air Referenced Velocity Reports
1	Capability of sending messages to support Air-Referenced Velocity Reports.

2.2.3.2.7.3.3.5 "TS Report Capability" CC Code Subfield

The TS Report Capability subfield of the CC Codes subfield is a one-bit Boolean flag in "airborne" format Aircraft Operational Status message (Type = 31, Subtype = 0) that **shall** be encoded as in Table 2.2.3.2.7.3.3.5:

Table 2.2.3.2.7.3.3.5: TS Report Capability Encoding.

TS Report Capability Flag	Meaning
0	No capability for Target State Reports
1	Capability of sending messages to support Target State Reports.

2.2.3.2.7.3.3.6 "TC Report Capability Level" CC Code Subfield

The TC Report Capability subfield of the CC Code subfield is a two-bit subfield in "airborne" format Aircraft Operational Status message (Type = 31, Subtype = 0) that **shall** be encoded as in Table 2.2.3.2.7.3.3.6:

Table 2.2.3.2.7.3.3.6: TC Report Capability Encoding.

TC Report Capability Flag	Meaning
0	No capability for Target State Reports
1	Capability of sending messages to support TC+0 Report only.
2	Capability of sending information for multiple TC reports.
3	(Reserved for future use.)

2.2.3.2.7.3.3.7 "Position Offset Applied" CC Code Subfield

The "Position Offset Applied"(POA) subfield of the CC Code subfield of the "surface" format Aircraft Operational Status message (Type = 31, Sybtype = 1) is a one-bit Boolean flag that the transmitting ADS-B subsystem **shall** set to ONE if the position that it is transmitting (in airborne position messages and surface position messages, §2.2.3.2.3 and §2.2.3.2.4) is known to be the position of the ADS-B participant's ADS-B position reference point (§TBD) rather than, for example, the position of the antenna of the navigation receiver. Otherwise, the transmitting ADS-B subsystem **shall** set this flag to ZERO.

2.2.3.2.7.3.4 "OPERATIONAL MODE (OM)" Subfield in Aircraft Operational Status Messages

The "Operational Mode (OM)" subfield is a 16-bit subfield ("ME" bits 25 through 40, Message bits 57 through 72) that indicates operational modes that are active on board the A/V in which the ADS-B transmitting subsystem resides. The format of the OM subfield in Aircraft Operational Status messages shall be as defined in Table 2.2.3.2.7.3.4 below.

Table 2.2.3.2.7.3.4: Operational Mode (OM) Subfield Format.

Msg Bit #	57	58	59	60	61	62 -- 72
"ME" Bit #	25	26	27	28	29	30 -- 40
OM Format	0 0		RA Active	IDENT Switch Active	Receiving ATC Services	Reserved
	0 1		Reserved			
	1 0		Reserved			
	1 1		Reserved			

2.2.3.2.7.3.4.1 OM Subfield Format Code

The first two bits of the OM subfield ("ME" bits 25 and 26) are reserved for selecting one of up to four OM subfield formats. For this (DO-260A) version of these MOPS, the OM subfield format code shall be ZERO.

2.2.3.2.7.3.4.2 "TCAS/ACAS Resolution Advisory Active" OM Code

The "TCAS/ACAS Resolution Advisory Active" (RA Active) Operational Mode code is a one-bit subfield ("ME" bit 11, Message bit 43) of the OM subfield in Aircraft Operational Status messages. The transmitting ADS-B subsystem **shall** set this code to ONE so long as a TCAS II or ACAS resolution advisory is known to be in effect; otherwise, it shall set this OM code to ZERO.

Note: The requirement for an interface by which the ADS-B transmitting subsystem may be informed when a TCAS/ACAS resolution advisory is active is specified in §TBD below.

2.2.3.2.7.3.4.3 "IDENT Switch Active" OM Code in Aircraft Operational Status Messages

The "IDENT Switch Active" Operational Mode code is a one-bit subfield ("ME" bit 12, message bit 44) of the OM subfield in Aircraft Operational Status messages. Initially, the "IDENT switch active" OM code **shall** be ZERO. Upon activation of the IDENT switch, the transmitting ADS-B subsystem shall set this code to ONE for a period of 20 ± 3 seconds; thereafter, the transmitting ADS-B subsystem shall set this OM code to ZERO.

Note: The requirement for an interface by which the ADS-B transmitting subsystem may be informed when the IDENT switch is active is given in §TBD below.

2.2.3.2.7.3.4.4 "Receiving ATC Services" OM Code in Aircraft Operational Status Messages

The "Receiving ATC Services" Operational Mode code is a one-bit subfield ("ME" bit 13, Message bit 45) of the OM subfield in Aircraft Operational Status messages. The transmitting ADS-B subsystem **shall** set this OM code to ONE when the transmitting ADS-B participant is receiving ATC services, as indicated by an appropriate interface on board the transmitting aircraft. Otherwise, this OM code **shall** be set to ZERO.

Note: The requirement for an interface by which the ADS-B transmitting subsystem may be informed when the aircraft is receiving ATC services is given in §TBD below.

2.2.3.2.7.3.5 Version Number Subfield in Aircraft Operational Status Messages

The "Version Number" subfield is a 3-bit ("ME" bits 41 through 43, Message bits 73 through 75) field used to indicate the Version Number of the formats and protocols in use on the aircraft installation. Encoding of the Version Number subfield shall be as shown in Table 2.2.3.2.7.3.5 (and in Table A-21 in Appendix A). ADS-B Receiving Subsystems conformant with this version of the 1090 MHz MOPS will initially assume a Version Number of ZERO (binary 000), until received Version Number data indicates otherwise.

Table 2.2.3.2.7.3.5: Version Number Encoding in Aircraft Operational Status Message.

Value	MOPS Version	MASPS Version
0	DO-260	DO-242
1	DO-260A	DO-242A
2-7	Reserved	Reserved

2.2.3.2.7.3.6 "NIC Supplement" Subfield in Aircraft Operational Status Messages

The NIC Supplement subfield in the Aircraft Operational Status message is a one-bit subfield ("ME" bit 44, Message bit 76) that, together with the TYPE subfield in Airborne Position and Surface Position messages, is used to encode the Navigation Integrity Category (NIC) of the transmitting ADS-B participant.

Note: The Navigation Integrity Category (NIC) is reported so that surveillance applications may determine whether the reported geometric position has an acceptable level of integrity for the intended use. See §2.1.2.12 of DO-242A, the ADS-B MASPS, for a fuller description of the Navigation Integrity Category.

Table 2.2.3.2.7.3.6 lists the possible NIC codes and the values of the position message type codes and of the NIC Supplement subfield that **shall** be used to encode those NIC codes in messages on the 1090 MHz ADS-B data link.

Table 2.2.3.2.7.3.6: Navigation Integrity Category (NIC) Encoding.

NIC Value	Containment Radius (R_C) and Vertical Protection Limit (VPL)	Airborne		Surface	
		Airborne Position Type Code	NIC Supplement Code	Surface Position Type Code	NIC Supplement Code
0	R_C unknown	0, 18, 22	0	0, 8	0
1	R_C < 20 NM (37.04 km)	17	0	N/A	N/A
2	R_C < 8 NM (14.816 km)	16	0	N/A	N/A
3	R_C < 4 NM (7.408 km)	16	1	N/A	N/A
4	R_C < 2 NM (3.704 km)	15	0	N/A	N/A
5	R_C < 1 NM (1852 m)	14	0	N/A	N/A
6	R_C < 0.6 NM (1111.2 m)	13	0	N/A	N/A
7	R_C < 0.2 NM (370.4 m)	12	0	N/A	N/A
8	R_C < 0.1 NM (185.2 m)	11	0	7	0
9	R_C < 75m *and* VPL < 112 m	10	0	6	0
10	R_C < 25m *and* VPL < 37.5 m	10	1	6	1
		21	0		
11	R_C < 7.5m *and* VPL < 11 m	9, 20	0	5	0

Note: "N/A" means "This NIC value is not available in the Surface Position Message formats."

2.2.3.2.7.3.7 Navigation Accuracy Category for Position (NAC_P)

The Navigation Accuracy Category for Position (NAC_P) is a four-bit subfield of the Aircraft Operational Status message ("ME" bits 45 to 48, Message bits 77 to 80) that announces 95% accuracy limits for the horizontal position (and for some NAC_P values, the vertical position) that is being currently broadcast in airborne position and surface position messages. Table 2.2.3.2.7.3.7 defines the accuracy limits for each NAC_P value.

Note: The Navigation Accuracy Category for Position (NAC_P) is reported so that surveillance applications may determine whether the reported geometric position has an acceptable level of accuracy for the intended use. See §2.1.2.13 of the ADS-B MASPS, DO-242A, for a fuller description of NAC_P.

Table 2.2.3..7.3.7: Encoding of Navigation Accuracy Category for Position (NAC_P)

NAC_P	95% Horizontal and Vertical Accuracy Bounds (EPU and VEPU)	Comment	Notes
0	EPU = 18.52 km (10 NM)	Unknown accuracy	1
1	EPU < 18.53 km (10 NM)	RNP-10 accuracy	1, 3
2	EPU < 7.408 km (4 NM)	RNP-4 accuracy	1, 3
3	EPU < 3.704 km (2 NM)	RNP-2 accuracy	1, 3
4	EPU < 1852 m (1 NM)	RNP-1 accuracy	1, 3
5	EPU < 926 m (0.5 NM)	RNP-0.5 accuracy	1, 3
6	EPU < 555.6 m (0.3 NM)	RNP-0.3 accuracy	1, 3
7	EPU < 185.2 m (0.5 NM)	RNP-0.1 accuracy	1, 3
8	EPU < 92.6 m (0.05 NM)	e.g., GPS (with SA on)	1
9	EPU < 30 m and VEPU < 45 m	e.g., GPS (SA off)	1, 2, 4
10	EPU < 10 m and VEPU < 15 m	e.g., WAAS	1, 2, 4
11	EPU < 3 m and VEPU < 4 m	e.g., LAAS	1, 2, 4

Notes for Table 2.2.3.2.7.3.8:

1. *The Estimated Position Uncertainty (EPU) used in the table is a 95% accuracy bound on horizontal position. EPU is defined as the radius of a circle, centered on the reported position, such that the probability of the actual position lying outside the circle is 0.05. When reported by a GPS or GNSS system, EPU is commonly called HFOM (Horizontal Figure of Merit).*

2. *Vertical Estimated Position Uncertainty (VEPU) is a 95% accuracy limit on the vertical position (geometric altitude). VEPU is defined as a vertical position limit, such that the probability of the actual geometric altitude differing from the reported geometric altitude by more than that limit is 0.05. When reported by a GPS or GNSS system, VEPU is commonly called VFOM (Vertical Figure of Merit).*

3. *RNP accuracy includes error sources other than sensor error, whereas horizontal error for NAC_P only refers to horizontal position error uncertainty.*

4. *If geometric altitude is not being reported, then the VEPU tests are not assessed.*

2.2.3.2.7.3.8 Reserved for Barometric Altitude Quality (BAQ)

The "Reserved for Barometric Altitude Quality (BAQ)" subfield of "subtype 0" Aircraft Operational Status message is a two-bit field ("ME" bits 51-52, Message bits 83-84) that **shall** be set to zero by equipment that conforms to these (RTCA DO-260A) MOPS.

Note: Non-zero versions of the BAQ subfield will be defined in future version of this MOPS. One possible future encoding for this subfield is described in a Note in §2.1.2.16 of RTCA DO-242A, the ADS-B MASPS.

2.2.3.2.7.3.9 Surveillance Integrity Level (SIL)

The Surveillance Integrity Level (SIL) is a two-bit subfield of "subtype 0" Aircraft Operational Status messages ("ME" bits 49 and 50, message bits 83 and 84) by which a transmitting ADS-B participant announces the integrity level associated with the R_C containment radius being broadcast in the NIC parameter. Table 2.2.3.2.7.3.8 defines the meaning of each SIL value.

Notes:

1. *The NIC parameter is broadcast partly in the TYPE subfield of airborne position and surface position messages, and partly in the NIC Supplement subfield of Aircraft Operational Status messages (§2.2.3.2.7.3.6).*

2. *The Surveillance Integrity Level (SIL) defines the probability of the integrity containment radius, R_C, used in the NIC parameter without being detected at the transmitting ADS-B participant. See §2.1.2.15 of the ADS-B MASPS, RTCA DO-242A, for a fuller description of SIL.)*

Table 2.2.3.2.7.3.8: Surveillance Integrity Level (SIL) Encoding.

SIL	Probability of Exceeding the R_C Containment Radius Without Detection
0	1×10^{-3} per flight hour or per operation
1	1×10^{-3} per flight hour or per operation
2	1×10^{-5} per flight hour or per operation
3	1×10^{-7} per flight hour or per operation

2.2.3.2.7.3.10 Barometric Altitude Integrity Code (NIC_{baro})

See the description of the Barometric Altitude Integrity Code, NIC_{BARO}, in 2.2.3.2.7.1.3.12.

2.2.3.2.7.3.11 Aircraft Size (Length and Width) Codes

The aircraft size (length and width codes) is a four-bit subfield ("ME" bits 21 to 24, Message bits 53 to 56) of "subtype 1" Aircraft Operational Status messages. This field describes the amount of space that an aircraft or ground vehicle occupies. The length and width codes are based on the actual dimensions of the transmitting aircraft or surface vehicle as specified in Table 2.2.3.2.7.3.11-A below. Each aircraft or vehicle **shall** be assigned the smallest length and width codes for which its overall length and width qualify it.

Note: For example, consider a powered glider with overall length of 24 m and wingspan of 50 m. Normally, an aircraft of that length would be in length category 1 (that is, have a length code of 1). But since the wingspan exceeds 34 m, it does not qualify for even the "wide" subcategory (width code = 1) of length category 1. Such an aircraft would be assigned length code = 4 and width code = 1, meaning "length less than 55 m and width less than 52 m."

Table 2.2.3.2.7.3.11-A: Aircraft Size (Length and Width) Encoding.

Length/Width Code (decimal)	Length Code			Width Code	Length (L) (meters)	Width (W) (meters)
	"ME" bit 49	"ME" bit 50	"ME" bit 51	"ME" bit 52		
0	0	0	0	0	0 < L < 15	0 < W < 11.5
1				1		11.5 = W < 23
2	0	0	1	0	L < 25	23 = W < 28.5
3				1		28.5 = W < 34
4	0	1	0	0	L < 35	28 = W < 33
5				1		33 = W < 38
6	0	1	1	0	L < 45	34 = W < 39.5
7				1		39.5 = W < 45
8	1	0	0	0	L < 55	38 = W < 45
9				1		45 = W < 52
10	1	0	1	0	L < 65	52 = W < 59.5
11				1		59.5 = W < 67
12	1	1	0	0	L < 75	65 = W < 72.5
13				1		72.5 = W < 80
14	1	1	1	0	L = 75	W < 80
15				1		W = 80

Each A/V for which the length code is 2 or more (that is, for which Length/Width Code is 4 or more) **shall** broadcast its length/width code while it is on the surface. For this purpose, the determination of when an aircraft is on the surface **shall** be as described in §TBD above.

2.2.3.2.7.3.12 Track Angle/Heading (TRK/HDG)

2.2.3.2.7.3.13 Horizontal Reference Direction (HRD)

The Horizontal Reference Direction (HRD) subfield of "subtype 1" Aircraft Operational Status messages is a one-bit field ("ME" bit 53, message bit 85) that indicates the reference direction (true north or magnetic north) for horizontal directions such as heading, track angle, selected heading, selected track angle, etc. This field **shall** be encoded as specified in Table 2.2.3.2.7.3.12 below.

Table 2.2.3.2.7.3.12: Horizontal Reference Direction (HRD) Encoding.

HRD Value	Meaning
0	True North
1	Magnetic North

2.2.3.2.7.3.14 "Reserved" Bits in Aircraft Operational Status Message

The "Reserved" Bits indicated in Figure 2-10 are reserved for future definition.

Note: The 12-bit "Reserved" Bits in "ME" bits 49 to 50 of "subtype 1" Aircraft Operational Status messages might be used in future to convey the transmitting aircraft's Mode A identity code to ATC providers that offer "radar-like services" to aircraft operating beyond the range of ATC surveillance radars.

2.2.3.2.7.3.15 “Reserved” Bits 55 - 56

2.2.3.2.7.4 RESERVED TYPE “23” ADS-B Event - Driven Messages for “TEST”

TYPE “23” ADS-B Message are Reserved Exclusively for Test Purposes.

2.2.3.2.7.5 RESERVED TYPE “24” ADS-B Event - Driven Messages for Surface System Status

TYPE “24” ADS-B Messages are Reserved for Surface System Status.

2.2.3.2.7.6 RESERVED TYPE “25” ADS-B Event - Driven Messages

TYPE “25” ADS-B Messages are Reserved for Future Expansion.

2.2.3.2.7.7 RESERVED TYPE “26” ADS-B Event - Driven Messages

TYPE “26” ADS-B Messages are Reserved for Future Expansion.

2.2.3.2.7.8 RESERVED TYPE “27” ADS-B Event - Driven Messages

TYPE “27” ADS-B Messages are Reserved for Future Expansion.

2.2.3.2.7.9 Extended Squitter Aircraft Status Messages (TYPE “28”)

The Extended Squitter Aircraft Status Message (TYPE “28”) is used to provide additional information regarding aircraft status. Subtype “1” is used specifically to provide Emergency / Priority status.

Specific formatting of the TYPE “28,” Subtype “1” is provided in Appendix A, Figure A-9.

2.2.3.3 ADS-B Message Update Rates

2.2.3.4 ADS-B Transmitted Message Error Protection

2.2.4 ADS-B Receiver Characteristics

2.2.5 ADS-B Transmission Device Message Processor Characteristics

2.2.5.1 ADS-B Transmission Device Data Processing and Message Formatting

2.2.5.1.1 ICAO 24-Bit Discrete Address

2.2.5.1.2 ADS-B Emitter Category Data

2.2.5.1.3 Air/Ground Status Data

2.2.5.1.4 Surveillance Status Data

2.2.5.1.5 Altitude Data

2.2.5.1.6 Time Data and Time Mark Pulse

2.2.5.1.7 Own Position Latitude Data

2.2.5.1.8 Own Position Longitude Data

2.2.5.1.9 Ground Speed Data

2.2.5.1.10 Ground Track Data

The ADS-B transmitting device shall accept own vehicle Ground track information via an appropriate variable data input interface and use such data to establish subfields in transmitted ADS-B messages as follows:

a. The “Status Bit for Ground Track” subfield in the Surface Position Message (See subparagraph 2.2.3.2.4) as specified in subparagraph 2.2.3.2.4.3,

b. The “Ground Track” subfield in the Surface Position Message (see subparagraph 2.2.3.2.4.2) as specified in subparagraph 2.2.3.2.4.4,

c. When Turn Rate data is not directly available, the ADS-B transmission device may use Ground Track data to establish the Turn Indicator Subfield as follows:

   (1). In the Airborne Velocity Information - Subtype “1 & 2” Messages (see subparagraphs 2.2.3.2.6.1 and 2.2.3.2.6.2) as specified in subparagraphs 2.2.3.2.6.1.13 and 2.2.3.2.6.2.13 respectively,

   (2). In the Airborne Velocity Information - Subtype “3 & 4” Messages (see subparagraphs 2.2.3.2.6.3 and 2.2.3.2.6.4) as specified in subparagraphs 2.2.3.2.6.3.13 and 2.2.3.2.6.4.13.

d. If Ground Track data is not available to the ADS-B transmission device, then the device shall enter ALL ZEROs into the “Status Bit for Ground Track” and “Ground Track” subfields specified in subparagraphs 2.2.3.2.4.3 and 2.2.3.2.4.4 respectively,

e. If Ground Track data and Turn Rate data are not available to the ADS-B transmission device, then the device shall ZERO the Turn Indicator Subfield:

(1). In the Airborne Velocity Information - Subtype "1 & 2" Messages (see subparagraphs 2.2.3.2.6.1 and 2.2.3.2.6.2) as specified in subparagraphs 2.2.3.2.6.1.13 and 2.2.3.2.6.2.13 respectively,

(2). in the Airborne Velocity Information - Subtype "3 & 4" Messages (see subparagraphs 2.2.3.2.6.3 and 2.2.3.2.6.4) as specified in subparagraphs 2.2.3.2.6.3.13 and 2.2.3.2.6.4.13 respectively.

f. Ground Track may be used in conjunction with Ground Speed data to arithmetically establish East/West Velocity Data (see subparagraph 2.2.5.1.2) and North/South Velocity Data (see subparagraph 2.2.5.1.3) if East/West and/or North/South Velocity Data is not available.

(1). When Ground Track data is used, the NUC_R (see subparagraph 2.2.5.1.22) data reported by the ADS-B transmitting device shall be consistent with the accuracy, range, and resolution that can be obtained by using Ground Track data as the input data to the arithmetic computations necessary.

(2). When Ground Track data is used, but Ground Track Data is not available to the ADS-B transmission device, then the device shall enter ALL ZEROs into all transmitted subfields that are computed based on Ground Track data.

Notes:

1. True Ground Track data may be unreliable at low ground speeds.

2. At very low ground speeds, the best estimate of an aircraft's or ground vehicle's ground track angle may be from a heading source rather than from the "track angle" output of a GNSS receiver.

2.2.5.1.11 Aircraft Identification (*or* Registration) Data

2.2.5.1.12 East / West Velocity Data

2.2.5.1.13 North / South Velocity Data

2.2.5.1.14 Vertical Rate Data

2.2.5.1.15 Turn Rate Data

2.2.5.1.16 Magnetic Heading Data

2.2.5.1.17 True Airspeed Data

2.2.5.1.18 Indicated Airspeed Data

2.2.5.1.19 Unused Section

2.2.5.1.20 Intent Change Data

2.2.5.1.21 IFR Capability Data

2.2.5.1.22 NUC_R Data

2.2.5.1.23 Current or Next Data

2.2.5.1.24 Trajectory Point / Leg Type

2.2.5.1.25 TCP / TCP + 1 Latitude Data

2.2.5.1.26 TCP / TCP + 1 Longitude Data

2.2.5.1.27 TCP / TCP + 1 Altitude Data

2.2.5.1.28 TCP / TCP + 1 Time-to-Go Data

2.2.5.1.29 Subtype (Op. Coord.) Data

2.2.5.1.30 Runway Threshold Data

2.2.5.1.31 Roll Angle Data

2.2.5.1.32 Go Around Data

2.2.5.1.33 Engine Out Data

2.2.5.1.34 Subtype (Aircraft Status) Data

2.2.5.1.35 Capability Class (En Route Operational) Data

2.2.5.1.36 Capability Class (Terminal Area Operational) Data